INSTALLATION PRACTICES OF CALIFORNIA HVAC CONTRACTORS: IMPLICATIONS FOR RESIDENTIAL BUILDING CODES

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BACKGROUND

The California Energy Commission (CEC) is engaged in research to determine appropriate compliance option calculation methods for the Title 24 Building Energy Efficiency Standards. In conjunction with this research, the CEC is analyzing the performance characteristics of gas furnaces, electric central air conditioners, and heat pumps. The current calculation methods for these appliances do not reflect certain site specific information, such as the presence and characteristics of crank case heaters (CCHs) for air conditioners, strip heaters for heat pumps, or the number of gas heated households with central air conditioners. Because these factors significantly affect total energy consumption, the present compliance option calculation methods may need to be adjusted based on current equipment installation practices. To determine this, field data on installation practices is required.

This report documents a study that was conducted by XENERGY, Inc. for the CEC and a consortium of California utilities. The utilities primarily involved in the study were Pacific Gas and Electric Company (PG and E), Sacramento Municipal Utility District (SMUD), Southern California Edison Company (SEC), and Southern California Gas Company (SCG).

The topics covered can be divided into two primary categories, those associated with central air conditioner installation practices, and those associated with heat pump installations. For air conditioners, the primary issues investigated were:

- the saturation of central air conditioners among newly constructed households that are centrally heated by natural gas;
- the prevalence of crank case heaters on central air conditioners installed in new residential construction; and
- the prevalence and motivation for installing central air conditioners exceed the minimum efficiency required by the California appliance standards.

For heat pumps, the primary issues investigated were:

- the primary methods used to size heat pumps;
- the prevalence of strip heaters on new heat pump installations, and the factors that influence when strip heaters are installed; and
- the prevalence and motivation for installing heat pumps that exceed the minimum efficiency required by the California appliance standards.

Data were gathered from a variety of sources in order to address these issues, including: a telephone survey of 200 HVAC installers, designed and implemented for this project; a review of equipment characteristics manufactured for sale in California; and existing household survey data provided by the major California utilities. The majority of analysis was based on the HVAC installer survey. The survey data were gathered from a stratified sample of HVAC installers located in six climatic regions throughout the state. The climatic regions were selected from among the 16 zones used for compliance option analysis under the Title 24 Building Standards. The Title 24 regions included in the survey were zones 3, 7, 8 and 9 combined, 10, 12, and 16.

CENTRAL AIR CONDITIONER SUMMARY

There is wide variation across climate zones in the saturation of central air conditioners among newly-constructed households that are centrally heated by natural gas. Saturation estimates were determined from two primary sources, the installer survey, and existing utility saturation surveys. As seen, according to the installer survey, nearly two-thirds of all new homes with gas furnaces in climate zones 3 and 7 are built without central air conditioners. In contrast, the vast majority of homes in the remaining zones are constructed with central air conditioners. Differences between the various estimates for the same zone are

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attributable, in part, to differences in the definitions of the zones for which the data were obtained.

Turning to the issue of CCH saturations, overall, 26 percent of air conditioner installtions made by respondents to the installer survey included CCHs. However, approximately two-thirds of all air conditioning istallations in zones 12 and 16, the two zones with the greatest heating requirements, had CCHs. Zones 8/9 and 10, which are quite mild, had very low saturations of CCHs. When crank case heaters are installed, they are almost always installed by the manufacturer, rather than installed at the site by a contractor.

A variety of factors were identified that influence the decision to install a CCH. The most significant factors were "climate", "to reduce maintenance problems and call-backs" and the fact that CCHs are "standard in most units". On a scale of 1 to 5, with five being "very important", no factor received a rating greater than 3.1, however. There was no statistically significant difference in the influencing factors across climate zones.

Based on the installer survey, the most commonly used control strategy for CCHs is "thermostatic", with a weighted average of 44 percent of repsondents indicating that this was their most frequent choice. Twenty eight percent of the respondents indicated that the CCH is left on at all times ("no control"), while 16 percent typically use a "positive temperature coefficient" control. The typical practice appears to vary significantly across climate zones, although the cell counts are too small to assess whether this variation is statistically significant.

Another area of inquiry for air conditioners concerned the frequency of installation of units that exceed the minimum efficiency standards required in Califronia, and the factors that affect when this occurs. The survey indicates that the majority of installers (77 percent overall, and 58 percent on a weighted average basis) do install some units with efficiencies that exceed the minimun standards. The most important fators that influence when this will occur include a "Title 24 Tradeoff (with a rating of 3.4 on a scale from 1 to 5), "Climate (3.1)", "Unit Availability (2.9)", and " Builder Dicates (2.9)". "Manufacturer or Utility Rebate" is not considered to be important (a rating of 1.3) by most installers. While the mean ratings vary by climate zone, the only statistically significant variation occurs for the "Climate" factor.

An area not fully investigated in this report is the prevalence of CCHs in heat pumps. The project management team assumed that all heat pumps sold in California are equipped with CCHs. In the course of researching the fequency of CCHs in central air conditioners, it was found that there are some models of heat pumps sold in California that do not have CCHs. The data used to support these findings are not sales weighted, however, so a firm conclusion on the prevalence of CCHs on heat pumps cannot be established.

HEAT PUMP SUMMARY

Three areas of inquiry were made in the installer survey that pertain to the sizing of heat pumps: the basis (e.g., cooling or heating loads) by which heat pumps are sized; the importance of climate in selecting heat pump size; and the calculation method used to estimate heat pump capacity.

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By far, the most common basis for sizing heat pumps is cooling load, with a weighted average response of 68 percent. "Both heating and cooling load" is the second most frequently reported method (15 percent), followed by square footage (12 percent). Only 3 percent of the respondents indicated that heating load was basis for heat pump sizing.

Survey respondents were asked to rate the imporatance of "climate zone" in the selection of a heat pump unit. For all zones, climate is at least "moderately important." The lowest rating was a 3.2 (zone 12) on a scale from 1 to 5, while the highest rating was a 4.8 for zone 16. The average for the aggregate sample was 3.8.

Regarding the most common calculation methods used to determine heat pump capacity, the most common approach employs the "Manual J" calculation methodology, with a weighted average of 44 percent of the respondents indicating this was their most frequently used method. The "ASHRAE heating and cooling load method" was second at 18 percent.

The survey investigated the prevalence of strip heaters among heat pump installations, and the factors that influence when they are installed. Overall, strip heaters are installed in approximately half of all heat pumps at the time of installation. However, in the colder zones (12 and 16), they are included in virtually all installations whereas for milder zones, they are rarely included. "To ensure comfort" is by far the most significant factor influencing when strip heaters are installed, with overall rating of 4.3 on a scale of 1 to 5. The next two most important factors are when the unit is "sized based on cooling loads" (rating of 3.2) and "climate" (3.1).

The final issue investigated concerned the prevalence of heat pump installations with efficiency ratings that exceed the minimum required by the California appliance standards. As with air conditioners, the majority of contractors indicate that at least some of their installations exceed the minimum efficiency standards. The most significant factors affecting when such installations are made are as a tradeoff to meet the Title 24 building standards (a rating of 3.5 on a scale of 1 to 5), and "climate" (3.0).